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REPORT  
OF  
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PROFESSOR W. R. NICHOLS,  
ON THE  
BOSTON WATER SUPPLY.

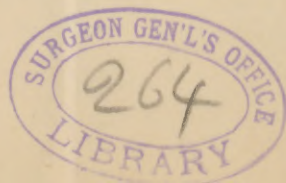
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[From the Third Annual Report of the Boston Water Board, City Doc. No. 79, 1879.]

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In the first Annual Report of the Water Board of the City of Boston, for the year ending April 30, 1877, was published a statement of the results of the weekly chemical examination of the Boston Water Supply, from July, 1876, to July, 1877.

Although the regular weekly examinations then ceased, occasional partial examinations have since been made in my laboratory, and the results are included in Table I. These results show that as in previous years, and as indeed is true in general of surface water, there is some variation from time to time; in the case of the Boston water, the average character of the water does not differ essentially from that previously reported. The water is always somewhat colored, owing to the presence of dissolved vegetable matter, and, although it generally appears quite clear to the eye, a good filter will remove some suspended matter, mostly vegetable; there is no evidence, however, that the color or suspended matter which are common to all soft surface waters are at all unwholesome, and we have every reason to congratulate ourselves on the character of our water-supply.



The examinations reported in Table I. have been made by what is known as Wanklyn's method. Although this method is in very general use, and is valuable in the sanitary examination of water, I have for some time felt a desire to examine our own and other waters by what is known as Frankland's method. This method, which is felt by many to give more valuable results, especially when it is a question of statistics, consists in evaporating a certain quantity of water to dryness under suitable conditions, and then burning the residue in closed vessels in such a manner as to convert all the *carbon* and *nitrogen* of the organic matter into gaseous substances, which can be readily collected and measured. In this way may be determined the "organic carbon" and "organic nitrogen," and the method comes nearer to giving the actual amount of organic matter than any other which has ever been employed.

The method is difficult and tedious, requiring the use of expensive and frangible apparatus, and consuming considerable time; for these reasons it can never be a popular method. Moreover, as is the case with every method employed for obtaining indications of the amount and character of the organic matter in a water, the results must be interpreted by a knowledge of the source from which the water is derived, and of its surroundings. In interpreting the results it is felt that great importance attaches to the relative proportion of carbon to nitrogen, for it is in general true that organic matter of vegetable origin contains a larger proportion of carbon, while organic matter of animal origin contains a larger proportion of nitrogen.

Since February 28 of this year I have had weekly examinations made of the Boston water by my assistant, Mr. J. E. Hardman, S.B., who, in order to perfect himself in the method, spent a considerable time in Dr. Frankland's laboratory in London. The results are recorded in Table II., and will make it possible to compare the character of our water, as far as the organic matter goes, with the great number of waters examined by the Rivers Pollution Commission in Great Britain, whose reports are a storehouse of information in the matter of water supply.

For the sake of comparison I have prepared a table,—Table III.,—in which are brought together some of the results obtained on other waters. It is a matter of regret that I have not yet, as I hope eventually to have, the record of the examination in this way of other waters in our own State. It may, however, be said that surface waters charged with dissolved vegetable matter are used much more frequently in this country, especially in New England and the Middle States, than in England and on the Continent, and on this account the

average amount of organic matter in our waters will no doubt prove larger.

There are, as far as I am aware, no earlier examinations of Boston water by this method, with which we can compare these results, except a few that were made in my laboratory in the spring of 1877. These results, which were obtained by Mr. C. N. Waite, S. B., I did not publish, because I did not feel that we had had sufficient experience with the method. I have now, however, no doubt that the results were substantially accurate. The average of seven determinations made between April 27 and May 11, 1877, was: organic carbon, 0.395, and organic nitrogen, 0.040. The ratio would be  $C : N = 9.9 : 1$ .

I desire to call attention to a fact which I have often emphasized, and which appears clearly in Tables II. and III., namely, that surface (and other) waters are subject to considerable variation, and, to obtain a satisfactory idea of the character of a given water, repeated examinations are necessary.

As this report may fall into the hands of some who are not familiar with our water, it may be said that the water, which is derived in part from Cochituate lake and in part from Sudbury river, is very soft; that the amount of solid matter varies from 3.75 to 5.75 parts in 100,000; that the chlorine is about 0.3, and that there is almost no nitrogen in the form of nitrites or nitrates.



TABLE I. — *Examination of Boston Water as drawn in the Laboratory of the Massachusetts Institute of Technology.*

(Results expressed in parts in 100,000.)

Date.	Ammonia.	"Albuminoid Ammonia."	Date.	Ammonia.	"Albuminoid Ammonia."
1877.			1878.		
July 5	0.0048	0.0155	June 25 . . . . .		0.0144
" 11	0.0051	0.0144	July 2	0.0035	0.0139
" 18	0.0051	0.0155	" 16	0.0035	0.0136
" 24	0.0056	0.0160	" 23	0.0045	0.0115
" 25	0.0053	0.0160	Aug. 13	0.0037	0.0136
Aug. 1	0.0051	0.0160	" 20	0.0037	0.0160
" 7	0.0045	0.0152	" 27	0.0035	0.0141
" 15	0.0048	0.0160	Oct. 22	0.0029	0.0141
Sept. 10	0.0045	0.0155	Nov. 7	0.0056	0.0181
" 26	0.0037	0.0181	Dec. 7	0.0067	0.0160
Oct. 3	0.0048	0.0195	1879.		
" 15	0.0043	0.0181	Feb. 12	0.0048	0.0149
" 20	0.0064	0.0176	" 20	0.0037	0.0144
1878.			" 27	0.0035	0.0133
March 22	0.0043	0.0144	March 6	0.0040	0.0128
" 30	0.0040	0.0128	" 13	0.0043	0.0125
April 20	0.0029	0.0141	" 20	0.0064	0.0128
May 4	0.0032	0.0123	April 4	0.0051	0.0165
" 14	0.0037	0.0112	" 11	0.0053	0.0149
June 4	0.0048	0.0136	" 17	0.0037	0.0160
" 12	0.0029	0.0125			
" 19	0.0040	0.0163	Average	0.0044	0.0148

TABLE II. — *Examinations of Boston Water by Frankland's Method.*

(Results expressed in parts in 100,000.)

Date.	Temperature in degrees.	Organic Carbon.	Organic Nitrogen.	Ratio.
1879.	Centigrade.			$\frac{\text{Carbon}}{\text{Nitrogen}}$
Jan. 28	. . . .	0.315*	0.042	7.5
Feb. 6	. . . .	0.369*	0.041	9.0
" 7	. . . .	0.342*	0.041	8.3
" 13	3.2	0.377*	0.043	8.8
" 20	2.7	0.504	0.049	10.3
" 27	3.0	0.438	0.041	10.7
March 6	3.2	0.475	0.043	11.0
" 13	6.2	0.385	0.046	8.4
" 20	3.2	0.517	0.064	8.1
" 27	5.2	0.485	0.069	7.0
April 4	4.7	0.485	0.092	5.2
" 11	5.2	0.418	0.061	6.9
" 17	6.4	0.412	0.059	7.0
" 24	8.1	0.366	0.034	10.8
May 1	8.7	0.407	0.057	7.1
" 8	10.5	0.397	0.051	7.8
" 15	13.3	0.362	0.039	9.3
" 22	15.4	0.327	0.042	7.8
" 29	16.9	0.390	0.060	6.5
June 5	18.4	0.464	0.060	7.7
" 12	18.3	0.355	0.050	7.1
" 19	17.4	0.370	0.051	7.3
Average	. . . .	0.408	0.052	7.9

\* Each of the results reported above, from January 28, until, and including, April 17, is the mean of two very closely agreeing determinations, but I have reason to fear that the four carbon determinations which are marked with a \* are a trifle too low. The nitrogen on the same dates I believe to be correct. After we had obtained complete control of the process I did not feel it necessary to make the determinations in duplicate on every occasion.

TABLE III. — *Examination of Various Waters by Frankland's Method.*<sup>1</sup>

(Results expressed in parts in 100,000.)

Date.	Description.	Organic Carbon.	Organic Nitrogen.	Ratio.
				$\frac{\text{Carbon}}{\text{Nitrogen}}$
Jan. to June, 1879 .	Average of 22 samples Boston Water . . . . .	0.408	0.052	7.9
	Unpolluted rain water. Average of 39 samples . . . . .	0.070	0.015	4.7
	Unpolluted upland surface water. Average of 195 samples . . . . .	0.322	0.032	10.1
	Unpolluted deep well water. Average of 157 samples . . . . .	0.061	0.018	3.4
	Unpolluted spring water. Average of 198 samples . . . . .	0.056	0.013	4.3
	<i>Unfiltered Thames Water, London.</i>			
	Lambeth Company . . . . .	0.325	0.076	4.3
Jan. 31, 1873 . . . .	Southwark & Vauxhall Company	0.285	0.050	5.7
Feb. 3, 1873 . . . .	Grand Junction Company . . .	0.246	0.033	7.5
Feb. 1, 1873 . . . .	Unfiltered Lee Water, London .	0.363	0.082	4.4
1873 . . . . .	<i>Variation in Filtered Water of Lambeth Co.</i>			
	Average of 12 monthly samples.	0.206	0.040	5.1
	Maxima (not at the same time) .	0.449	0.065	6.9
	Minima (not at the same time) .	0.130	0.021	3.0

<sup>1</sup> From the Sixth Report of the Rivers Pollution Commission.



